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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte STEVEN C. AVANZINO

Appeal 2008-3570
Application 10/726,992
Technology Center 1700

Decided: September 29, 2008

Before EDWARD C. KIMLIN, THOMAS A. WALTZ, and
KAREN M. HASTINGS, *Administrative Patent Judges*.

WALTZ, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant seeks review under 35 U.S.C. § 134 from the Examiner's rejections of pending claims 1-20 in the final Office Action, dated June 5, 2006. This Board has jurisdiction under 35 U.S.C. § 6(b). For the reasons given below, the rejections of the Examiner are REVERSED.

The present application is directed to a method of etching a copper material, comprising steps of contacting the material with a first and a second solution. Claim 1 is illustrative and reproduced below.

> 1. A method of etching a copper containing material, comprising:
>
> contacting the copper containing material comprising at least about 10 % by weight copper with a first solution to convert at least a portion of the copper containing material to a passivating film, the first solution comprising a peroxide compound, a first organic acid, and water and having a pH from about 2 to about 6; and
>
> contacting the passivating film with a second solution to remove the passivating film, the second solution comprising a second organic acid and water.

In addition to the admitted prior art, the Examiner relies on the following prior art references as evidence of unpatentability:

Uozumi	6,261,953 B1	July 17, 2001
Kondo	6,596,638 B1	July 22, 2003
Singh	6,594,024 B1	July 15, 2003
Shimazu	6,547,843 B2	Apr. 15, 2003
Miller	6,719,920 B2	April 13, 2004

The pending claims stand rejected and are presented for review as follows:

1. Claims 1-3, 5, 7-11, 14 and 16 stand rejected under 35 U.S.C. § 103(a) as obvious over Uozumi in view of Kondo.

2. Claim 12 stands rejected under 35 U.S.C. § 103(a) as obvious over Uozumi in view of Kondo, as applied to claim 10, and further in view of Miller.

3. Claim 13 stands rejected under 35 U.S.C. § 103(a) as obvious over Uozumi in view of Kondo, as applied to claim 10, and further in view of Shimazu.

4. Claims 17-20 stand rejected under 35 U.S.C. § 103(a) as obvious over Uozumi in view of Kondo and in view of Singh.

5. Claims 4, 6, and 15 stand rejected under 35 U.S.C. § 103(a) over Uozumi in view of Kondo and further in view of the admitted prior art.

FINDINGS OF FACT (FF)

The following findings of fact are made based on substantial evidence in the record.

1. Uozumi teaches a two-step etching process for copper materials. The first step involves exposing the surface of the copper material to an aqueous solution of hydrogen peroxide and ammonia. This causes a reaction with the copper, forming a layer of copper oxide on the surface. The copper oxide layer includes an ammonium complex. This layer does not etch out the copper. Col. 9, ll. 42-50.

2. Uozumi further teaches that the oxide layer formed in the first solution is subsequently removed, or etched, with a solution having a weak oxidation potential, such as dilute hydrochloric acid or dilute aqueous ammonia. Col. 9, ll. 50-55.

3. The inventor in Uozumi found "with pH of 10 or less, an oxide film is formed on the surface of the copper film[,] whereas with pH of greater than 10, copper is etched." Col. 9, ll. 55-59.

4. In Kondo, Fig. 9 illustrates that a citric acid-based polishing solution is within the domain of corrosion, forming soluble Cu^{2+} ions and

having a pH of about 2 and a weakly positive oxidation-reduction potential. It further shows an aminoacetic acid-based polishing solution is within the domain of passivation, forming insoluble copper oxide (CuO), having a pH of about 7-8 and a weakly positive oxidation-reduction potential. *See* col. 6, ll. 36-48; col. 12, ll. 61-65. Kondo teaches the desirability of using a polishing solution in the corrosive, rather than passivating, domain. Col. 6, ll. 48-50.

PRINCIPLES OF LAW

"Section 103 forbids issuance of a patent when 'the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.'" *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1734 (2007)

The question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art, (2) any differences between the claimed subject matter and the prior art, (3) the level of skill in the art, and (4) where in evidence, so-called secondary considerations. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966)

A proper analysis under § 103 requires, inter alia, consideration of two factors: (1) whether the prior art would have suggested to those of ordinary skill in the art that they should make the claimed composition or device, or carry out the claimed process; and (2) whether the prior art would also have revealed that in so making or carrying out, those of ordinary skill

would have a reasonable expectation of success. *Velander v. Garner,* 348 F.3d 1359, 1363 (Fed. Cir. 2003).

"A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. The degree of teaching away will of course depend on the particular facts; in general, a reference will teach away if it suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the result sought by the applicant." *In re Gurley*, 27 F.3d 551, 552-53 (Fed. Cir. 1994).

DISCUSSION

In the Final Office Action, claim 1 was rejected as obvious over Uozumi in view of Kondo. The Examiner contends that Uozumi teaches a method of etching copper. The method involves first exposing a copper material to a hydrogen peroxide, and then removing the copper oxide formed using an acid solution., where the acid may be an organic acid. Ans. 3. The Examiner finds that the difference in Uozumi from claim 1 is Uozumi's first solution of aqueous ammonia and hydrogen peroxide instead of an aqueous organic acid and peroxide. Ans. 3-4.

The Examiner finds that Kondo discloses a method of polishing copper, using aqueous citric acid and hydrogen peroxide, the solution having a pH in the range of 2 – 6. The Examiner finally contends that a person of ordinary skill would find it obvious to replace the first solution of Uozumi (aqueous ammonia and hydrogen peroxide) with that of Konda (aqueous

citric acid and peroxide). The Examiner's rationale is that one skilled in the art would have been motivated to replace the first solution of Uozumi with the more corrosive one of Konda because the higher etch rate and a wide range of stability of the Kondo solution would provide better process control. Ans. 4.

The Examiner also notes Uozumi's second solution is an mineral acid, rather than the organic acid of claim 1. The Examiner then asserts that one skilled in the art would have substituted the Kondo organic acid solution, without peroxide, because the organic acid solution would dissolve any byproduct of the first reaction and, lacking peroxide, would stabilize the surface from further oxidation. Ans. 15.

Appellant disputes the Examiner's conclusion of obviousness, both to the substitution of the Kondo solution for the first Uozumi solution, and for the modified (i.e., without peroxide) Kondo solution for the second Uozumi solution.

As to the first Uozumi solution substitution, Appellant argues that the substitution would not be obvious because (1) it would fundamentally change the process of Uozumi, (2) Kondo is directed to a corrosive solution to achieve high etch rates for removing large amounts of material, and (3) Kondo teaches against the use of citric-acid/hydrogen peroxide solutions for the purpose of forming an insoluble passivation layer. App. Br. 5-6. Appellant then argues that one skilled in the art would not find substituting the Kondo solution for the second Uozumi solution obvious because it would contradict the basic requirements of the second Uozumi solution. Uozumi's second solution is specified as a weakly oxidizing solution, which Uozumi achieves with a dilute inorganic acid. In contrast, an organic acid,

as used in Kondo, has no oxidation potential. Appellant asserts that organic and inorganic acids are not equivalent. App. Br. 9.

We find Appellant's arguments persuasive. A critical limitation of the first solution of claim 1 is that this solution must convert a portion of a copper material to a passivating film. One of ordinary skill in the art would have understood passivation of a metallic material as the reaction of metal at the surface with formation of a protective oxide film that inhibits further corrosion.[1] In contrast, one of ordinary skill in the art would have distinguished this from corrosion, which is gradual destruction of a metal or alloy due to chemical processes such as oxidation.[2] One skilled in the art would understand passivation as the formation of a thin film of oxidation products on the surface, serving as a barrier to further oxidation or corrosion.

Uozumi discusses the prior art of etching, noting that aqueous solutions of ammonia/hydrogen peroxide or hydrochloric acid/hydrogen peroxide are used to etch copper, but these leave a rough surface. These etch copper (i.e., are corrosive). Uozumi addresses this problem with a two-step etching process, the first step using a mildly alkaline aqueous solution of hydrogen peroxide and ammonia. This forms a thick oxide film including an ammonia complex on the surface, which does not etch out the copper. FF 1. This oxide film is then etched out using either an acid with weak oxidizing properties, such as dilute hydrochloric acid or an alkali with weak oxidizing properties, such as dilute aqueous ammonia. FF 2. Though not using the term, one of ordinary skill in the art would have recognized this

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[1] *See* McGraw-Hill Dictionary of Scientific and Technical Terms 1455 (Sybil P. Parker ed. 1994).
[2] *See* McGraw-Hill Dictionary of Scientific and Technical Terms 467 (Sybil P. Parker ed. 1994).

first step as forming a passivation layer. As noted in Uozumi, "The experiments conducted by the present inventor demonstrated such a property that with pH of 10 or less, an oxide film is formed on the surface of the copper film [passivated], whereas with pH of greater than 10, copper is etched [corroded]." FF 3. The second solution of Uozumi is then used to dissolve, or "etch" this oxide or passivation layer. FF 2.

In contrast, the solution in Kondo is intended to be corrosive and not passivating. Fig. 9 of Kondo indicates that the citric acid and nitric acid-based polishing solutions having pHs of 2 and 3, respectively, and positive oxidation –reduction potentials are within the domain of corrosion, in which soluble Cu^{2+} is formed, whereas an aminoacetic acid-based polishing solution has an alkaline pH and is in the domain of passivation in which insoluble copper oxide (CuO) is formed. FF 4. Thus, we determine that one of ordinary skill in the art would not have expected that a substitution of the Kondo solution (citric acid / hydrogen peroxide, pH 3) for the first Uozumi solution (ammonia / hydrogen peroxide, pH 8-10) would likely succeed in producing the desired insoluble passivation (oxide) layer on the copper surface. *Velander v. Gardner*, 348 F.3d at 1363. Kondo, we further determine, teaches away from such a combination, as it indicates its solution is corrosive, not passivating, and would discourage one skilled in the art from following the line of development of the Appellants. *Gurley*, 27 F.3d at 552-53.

Accordingly, we determine that Appellant has established that the Examiner committed reversible error in rejecting claim 1 as obvious over Uozumi in view of Kondo. The remaining claims depend on claim 1 and thus the rejection of these claims is not sustained since Miller, Shimazu,

Singh, and the "admitted prior art" have been applied to show limitations of the dependent claims and do not cure the deficiencies discussed above. The decision of the Examiner is reversed.

REVERSED

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